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ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION

Starvation in Antelope with Stomachs Full of Feed

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Heavy snows in northern Arizona completely covered vegetation available to antelope herds. After native and supplemental feed became available, antelope died from starvation with stomachs full of feed, apparently due to rumen malfunction. No ciliate protozoa were observed in the rumen contents although several types of bacteria similar to those described in domestic and wild ruminants were observed.

Seven feet of snow fell on northern Arizona between December 13 and 21, 1967. All native vegetation available to antelope (Antilocapra americana) was completely covered. The herds were subjected to low temperatures, and forced to move through deep snow. When conditions permitted, the Arizona Game and Fish Department provided alfalfa hay as supplemental feed to the antelope herds. Following snowmelt, native browse again became available. Soon thereafter, antelope were found dead on the range with their stomachs full to a point of impaction. In some of the dead antelope, rumen ingesta consisted primarily of fourwing saltbrush (Atriplex canescens (Pursh) Nutt.) and Bigelow sagebrush (Artemisia bigelovii A. Gray), while in others the ingesta was mainly alfalfa hay. Since the antelope bone marrow was red and gelatinous and fetuses were bloody, death was attributed to starvation. Atrophy of body fat was apparent in all animals examined. These antelope were without feed 10 to 14 days before either native or artificial feed was available.

Rumen samples were collected from six dead antelope on January 13, 1967, and preserved in 10 percent formalin for analysis of the rumen microflora and fauna (table 1). One rumen sample was carried to the laboratory for analysis prior to addition of formalin. This sample was analyzed within 2 hours after collection. Observations and microorganism counts were made by techniques similar to those reported by Pearson (1965).

Microscopic examination of the rumen contents revealed no ciliate protozoa in any of the six dead antelope. Bacteria observed included various cocci, rod-shaped, and spiral organisms, similar to those described in domestic and wild ruminants (Bryant 1959; Hungate 1960; Pearson 1965, 1967). Direct microscopic examination of the nonformalin rumen sample revealed that many of the bacteria were viable. The average number of bacteria counted in this sample was 4.3 billion/ml. of rumen fluid, which is similar to counts reported from other rumi-

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Table 1.--Notes taken January 13, 1968, concerning antelope that died following a severe snowstorm December 1967

Animal number	Sex	Age	Remarks
1	Female	3-5 years	Animal dead approximately 24 hours (1 to 2 days); had two bloody fetuses; rumen full of feed (alfalfa hay, sagebrush, and saltbush); true stomach empty, others full; lungs bloody and ulcerated; femur bone marrow red and gelatinous; content in rumen not completely frozen, reticulum frozen.
2	Male	Yearling	Animal dead 3 to 4 days; rumen contents frozen; all stomachs full of feed (sagebrush and saltbush in rumen); bone marrow red and gelatinous.
3	Female	Fawn	Animal dead 3 to 4 days; rumen contents frozen; all stomachs full (sagebrush and saltbush in rumen); bone marrow red and gelatinous.
4	Female	3-5 years	Animal dead 3 to 4 days; rumen contents frozen; two embryos more normal than number 1 in color, apparently less reabsorption; bone marrow red and gelatinous but somewhat firmer and not as red as number 1; rumen full of saltbush and sagebrush.
5	Female	Mature	Animal died within last 12 to 16 hours; not frozen; stomachs full of alfalfa hay; two bloody fetuses; bone marrow red and gelatinous.
6	Female	5 years	Animal attacked by coyote in last 8 to 12 hours, bone marrow less red and gelatinous than number 5 or 1, indicating more fatty tissue; rumen full of alfalfa hay; rumen contents taken to laboratory in fresh condition.

nants. Of the total bacterial numbers in the rumen contents of the six antelope, two types were predominant: (1) Selenomonads, 10.5 percent, and (2) Quin's ovals, 12.6 percent (fig. 1). These amounts are apparently higher than would be expected on roughage diets, although selenomonads may constitute 20 to 40 percent of a total colony count from steers fed corn and urea (Hungate 1966). Quin's ovals in rumen contents apparently are so scarce that they are seldom mentioned in rumen studies. These organisms have not been successfully cultured (Purdom 1963).

Counts of bacteria from contents of an antelope killed during the regular hunting season (September 23, 1968) were similar in total number and kind to bacteria observed in antelope that starved. The average number of bacteria counted in this apparently normal animal was 5.2 billion/ml. of rumen fluid with 14.3 percent selenomonads and 6.5 percent Quin's ovals. These subsequent findings suggest that the antelope that died from starvation contained a normal rumen microflora. Quin's ovals were fewer in the normal animal. The average number of protozoa counted in the normal animal was 800/ml. of rumen fluid. According to descriptions given by Zielyk (1961), the protozoa were Entodinium dubardi.

Quin's ovals have been described as being closely related to the selenomonads (Hungate 1966). McGaughey and Sellers (1948) found these ovoid forms overwhelmingly predominant in rumen contents of sheep fed meadow hay and mangolds (sugar beets). The organisms were absent or in low numbers when the sheep were fed only meadow hay, but within 3 days of the addition of mangolds to the diet they appeared in great numbers. Apparently these organisms thrive on high carbohydrate diets, which produce excess fatty acids in the rumen.

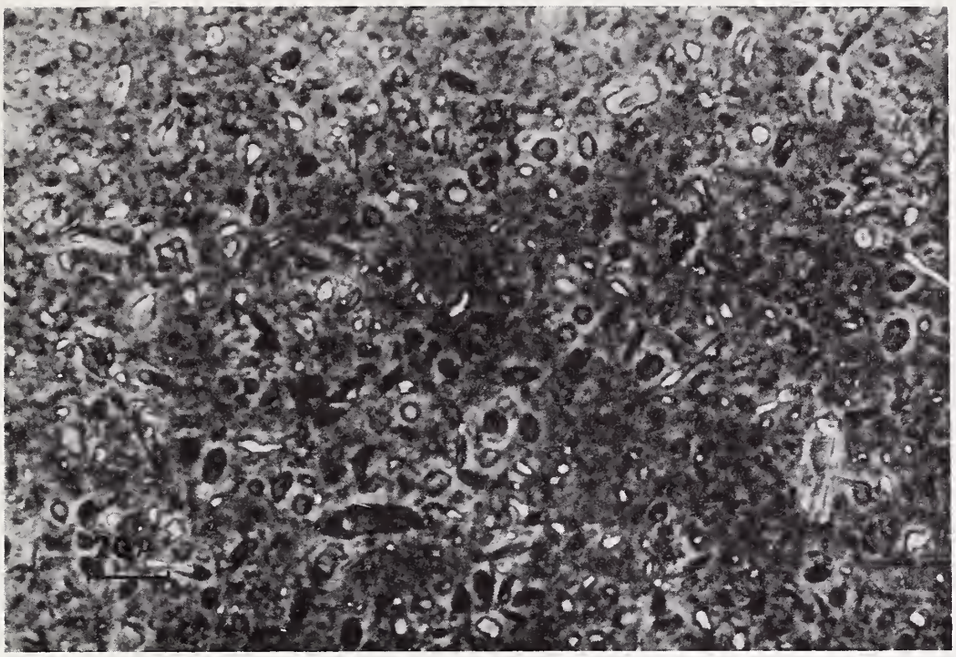

Figure 1.--
Photomicrograph of rumen micro-organisms from antelope that died from starvation.

Excess fatty acids are produced when large amounts of concentrated feeds such as mangolds are added to the diet, or when the rumen wall does not absorb the nutrients quickly enough to remove the concentrated starch and glucose byproducts from the rumen. The latter occurs in cases of rumen atony.

Acid indigestion, rumen atony, and death in domestic animals are associated with overeating of high-carbohydrate concentrates, and with animals that have been semistarved and later gained access to lush feeds (Hungate 1966, Kingsbury 1964). In these cases, acid production was greater than the normal neutralizing mechanisms of the rumen could handle, which resulted in low pH and cessation of rumen action. During prolonged fasting, ruminal fluid composition approaches that of saliva (Turner and Hodgetts 1955); therefore, a starving animal would be expected to have a ruminal fluid pH near 8. The rumen fluid pH in these antelope varied between 6.3 and 7.0, which indicates acid was being produced.

Antelope herds known to visit an available haystack in the area during the storm survived. The available hay prevented complete starvation and rumen malfunction. When native feed became available after the storm, the rumen quickly resumed normal absorption and activity, which averted death. Deer have survived in similar circumstances where some native forage was available when hay was fed, while others without native forage died with stomachs full of feed (Doman and Rasmussen 1944). Animals generally lose weight in winter, but available native or artificial forage provided immediately with onset of stress periods apparently prevents rumen malfunction and eventual death.

If supplemental feeding is considered as a management measure, to be effective it should be started before the starvation process has become irreversible. The physiology of starvation is still too poorly understood in most wild ruminants to make specific feeding recommendations for specific situations. This is an area where research is clearly needed. Physiological and nutritional studies of wild ruminants under controlled stress conditions should include:

1. Rates of fermentation of the rumen digesta.
2. Molar proportions and amounts of rumen volatile fatty acids.
3. Chemical and botanical analyses of the digesta.
4. Total and differential counts of rumen micro-organisms from normal animals and those under varying degrees of stress.
5. Gas production by the rumen digesta.
6. Rumen pH influence on microbial activity.
7. Isolation and culture of the micro-organisms.

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